Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 150 (2016) 1563 – 1566

Procedia Engineering

www.elsevier.com/locate/procedia

International Conference on Industrial Engineering, ICIE 2016

Silicon-Organic Modifying Additives for Protection of Wooden Architecture Monuments of Siberia

B.V. Krutasov*, V.S. Molchanov , I.B. Krutasova

The Novosibirsk State University Of Architecture And Civil Engineering(sibstrin), 113, Leningradskaya Street, 630008, Novosibirsk, Russia

Abstract

The paper considers the issues of protection of wooden architecture monuments of Siberia by means of wood modification methods. It provides an overview of protective compositions based on the silicon-organic compounds that are applied onto the wood surface with pulverizing and may be used as effective protective means.

Peer-review under responsibility of the organizing committee of ICIE 2016

Keywords: wooden architecture monuments; wood modification; silicon-organic compounds; weathering resistance; durability.

1. Introduction

The biggest and unique reserve of national wooden architecture in Russia is the Russian North. However, rich in architectural monuments and other Russian cities, such as Suzdal, Tomsk, Irkutsk. Novosibirsk is a fairly young city, and has a small number of monuments of wooden architecture. But for him, the actual problem is the salvation of the little that was left of wooden architecture (Fig. 1-3).

The main objective of preservation of monuments of wooden architecture is to increase the longevity of the service life of wood, maintaining its mechanical properties. In conditions of variable humidity and the absence of proper timely repair of monuments gradually eroded. Destruction of the wood under the influence of the environment and of microorganisms can be suspended by means of various preservatives.

A large number of wood preservatives, as well as conservation technologies: diffusion processes, the use of preservative gases impregnated elements after prior disassembly of buildings [1]. In each case the selected method

* Corresponding author. Tel.: +7-913-749-0307
E-mail address: nmashkin@yandex.ru

Peer-review under responsibility of the organizing committee of ICIE 2016
doi:10.1016/j.proeng.2016.07.117

and compositions of the most suitable for the conservation of monuments, taking into account environmental issues, not only direct but also indirect environmental safety material for the monument.

This issue is important for the monuments of wooden architecture of the city of Novosibirsk, a feature which is quite a high degree of safety, since they have an age of about 100 years.

Fig. 1. The building in Novosibirsk

Fig. 2. Zashiverskaya Saviour's Church (circa 1700, Novosibirsk). Akademgorodok. Open-air museum

Fig. 3. The facade of a wooden building in the city of Tomsk

2. Experimental

In NSABU (Sibstrin) conducted long-term studies of methods of protection of monuments of wooden architecture with the use of wood modification technology synthetic polymers (phenol-formaldehyde, epoxy, etc.) [2].

Significant experience of modifying wood to improve its resistance and durability in a variety of media has allowed as a major modifier of wood repellents landmarks recommend preparations based on potassium ethyl silicate (Aqua Phone) and styrene butadiene latex SKS-65 GP [3, 4].

Potassium Ethyl silicates are surfactants, molecules which, due amphiphilic structure, are capable of being adsorbed on the hydrophilic surface, navigate to it its polar group. The hydrophobic group, usually an organic radical, with the nonpolar faces the environment - air. Due to this, the hydrophilic surface of the material before becoming hydrophobic. Resistance hydrophobic effect depends on the strength of the connection with the water-repellent material surface material: the most reliable fixation is ensured in the event of a chemical bond with the surface molecules of water repelling agent. These properties are water repellents based on silicone compounds (CBS), which is due to the specific set of properties associated with structural features of the molecules other than the organic compounds [4].

Protective compositions based on organosilicon compounds are more efficient than their organic counterparts, and their characteristic properties are high reactivity, low dependence of the physical and mechanical properties on the temperature, high resistance to thermal and thermo-oxidative degradation, frost. Silicone compounds are sufficiently resistant to weak acids and alkalis and many solvents, fuels and mineral oils [5].

Studies have shown that the most efficient and technologically convenient are methylsiliconate alkali metals (MSC) for the surface treatment of wooden constructions materials - water-soluble silicone compounds, which do not require the use of organic solvents or preparation of emulsions used in the form of highly diluted aqueous solutions and are the cheapest of all the silicone products [4]. By-products formed by the reaction of alkali carbonation with carbon dioxide air, are non-toxic compounds - potassium carbonates. The catalyst for the chemical processes of hydrolysis and polycondensation of the organosilicon compounds is air carbon dioxide, alkali metal methylsiliconate therefore be called hydrophobizing versatile enough modifier timber.

Wood modified composition comprising a styrene-butadiene latex SKS-65 GP (dry matter more than 47%, the viscosity of the VZ-4 - 24) - 10-12% and 35-45% aqueous solution of potassium methylsiliconate - AquaPhone (TU 6 -02-1824) - 88-90%. For comparison were also used traditional phenol [2]. Impregnation of wood was carried out by the method of "vacuum - atmospheric pressure" and the method of spraying according to GOST 24329 "Wood modified. modification "methods.

Physical and mechanical properties of the water-repellent (modified) wood (compressive strength and flexural deformation of swelling, the degree of impregnation, the density) was determined by the method CNIISK. VV Kucherenko at 10h10h150 mm size samples. The properties of the modified wood (with the through impregnation) are presented in Table. 1.

Table 1. The properties of modified wood

Timber	impregnation ratio, %	average density kg / m3	Strength under radial compression, MPa	Strength in static bending, MPa	Impact strength kJ / m2
natural Birch	–	650	11,0	145,2	55,0
natural Pine	–	510	7,5	94,3	58,0
Birch, modified with phenospirits	23,7	732	15,8	148,1	41,5
Pine, modified with phenospirits	27,2	721	15,6	110,8	43,2
Birch modified latex-silicon-organic modifier	34,0	750	19,1	164,3	45,4
Pine modified latex-silicon-organic modifier	37,3	739	18,7	180,5	49

The reliability of the results was assessed by statistical processing in accordance with GOST 16483.0 "Wood. Test methods. General requirements".

3. Conclusions

As a result of studies found that when used to modify wood composition based on potassium siliconate achieved a significant level of increase of the physical and mechanical properties of wood, comparable with traditional phenol. Considering manufacturability and ease of use of MSCs, should be advised of their industrial use for the protection of wooden monuments.

References

[1] Intercession EN, Chemical and physical foundations increased durability of wood, Saving the monuments of wooden architecture using organometallic compounds, DIA, Moscow, 2009.
[2] N.A. Mashkin, The operational stability of modified wood in building products, NSABU, Novosibirsk, 2001.
[3] N.A. Mashkin, B.V. Krutasov, Development and research of structural models of modified wood, Building materials. 3 (2006) 35–36.
[4] O.N. Mashkin, S.G. Ershov, B.V. Krutasov, A.G. Manshin, Protective treatment of construction materials silicone hydrophobizing, Monograph, NSABU (Sibstrin), Novosibirsk, 2013.
[5] M.V. Sobolewski, G.V. Motsar, V.R. Rosenberg, Carbofunctional organosilanes and organosiloxanes, Chemistry, Moscow, 1990.